

SPONTANEITY OF NORMAL AND
MENTALLY DEFICIENT SUBJECTS IN
SELECTIVE LEARNING

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The Problem

The concept of the mental age gave a new basis for a comparison of subjects of different grades of intelligence. Such groups, while averaging the same on a battery of performances, often show characteristic failures and successes (2), (3), (4), (5), (6), (8), (13), (16), (17), (18), (22), (23), (24).

The present study is a comparison of normal and mentally deficient children on selective learning of geometric designs. The designs were presented on cards 3" x 4". The subject was asked to learn in each of thirty rows which card (when pressed with a wand) would sound a buzzer. The use of a common configurational characteristic in the correct choices was left to the spontaneity of the subject.

Experimental Set-Up

Subjects

The mentally deficient subjects were patients at the Wayne County Training School, Northville, Michigan. There were 57 subjects in this group, 22 girls and 35 boys, ranging in chronological age from 9 years, 10 months to 26 years 5 months; in mental age (estimated from the most recent Stanford Binet) from 6 years 7 months to 11 years 0 months; in I.Q. from 60 to 69. The mean C.A. was 15 years 3 months, the mean M.A. 9 years 4 months, the mean I.Q. 64.8. Nine of these subjects scored below norms on the Stanford Achievement Test. Since the academic training of this group ceases

at 16, chronological ages above this level were ignored in computing educational retardation. This procedure showed a retardation from 3 years 0 months to 7 years 3 months in educational age, with a mean retardation of 5 years 4 months¹. These subjects were selected alphabetically on the basis of I.Q. 60-69.

The normal subjects were wards of the State Public School, Coldwater, Michigan. They were selected with an I.Q. range of 90-110 but on being retested three scored above and three below these limits giving a range of 84-118 with a mean of 99.2. The original plan was to include only subjects whose grade placement was at life age level, but so many of this group had life ages and achievement scores above their grade placement that it was necessary to allow a grade displacement of two years in order to get a sufficient number of subjects. There were 54 subjects in this group, 36 boys and 18 girls, ranging in chronological age from 7 years 5 months to 18 years 5 months with a mean of 11 years 8 months; in mental age from 7 years 6 months to 15 years 10 months with a mean of 11 years 5 months. Three in the first grade and two who were out of school were not given Stanford Achievement Tests. The others ranged from a retardation of 3 years 1 month to an acceleration of 2 years 10 months in educational age with an average deviation from chronological age of 1 year 1 month. The mean school achievement showed an acceleration of 7 months¹.

These two groups of subjects probably had decidedly more similar backgrounds than is usually found in children of different intellectual levels. Both groups came from a very poor social and economic environment to institutional routine. Psychological and educational testing were included in the regular programs of both schools. Both groups of subjects spoke of psychological investigations as "brain testing" and

1. In both schools the Stanford Achievement Tests are given annually as a measure of progress for the year. It is entirely possible that practice on previous tests and on similar exercises devised by the teachers may tend to give these groups a higher rating than would be scored by comparable groups unfamiliar with the tests.

regarded being a subject as somewhat of a mark of inferiority. The State School wards associated it with consideration for transference to the state institution for the feeble-minded. In an effort to offset this prejudice the experimenter explained to each subject that this experiment was not connected with institutional records, that she was asking him to help her in a study of how people learn. In most cases this explanation seemed to be sufficient for obtaining full cooperation. Teachers of both institutions reported that the children apparently considered it rather a distinction to be asked to participate. Subjects who showed opposition were discontinued. One normal subject who said he didn't like the buzzers was dropped. One of the mentally deficient girls asked that she not be called again, another was discontinued because of her apparent fright, and several others had incomplete records on account of illness, elopement, or parole. None of these discontinued subjects was included in the above descriptions.

In addition to these two groups of subjects there were nine subjects with an I.Q. range 75-90 and six superior girls. The chronological ages of these subjects ranged from 7 to 16 years.

Material, Apparatus, and Procedure

The geometric designs were outlined in india ink on cards 3" x 4". In order to make the separate cards stand out more distinctly, a black one-quarter inch border was printed on the side edges of the cards. Four series of 30 rows each, 5 cards in a row, were used in the experiment. Thirty outer geometric designs, arranged so that each occurred in every column once, but never in succeeding rows nor twice in the same row, were used in three of these series, referred to as the duplico, idem and uni-inscribed series. In the duplico series (see figure 1) the same thirty designs, reduced in size, were used as inner designs. These inner designs were arranged according to the same principle as the outer designs. When a design appeared inside itself, pushing that card would sound the buzzer, i.e., the configurational characteristic for the duplico series was an inner design like the outer design. In the idem series only five inner designs were used, all occurring in every row, each one

Duplico Series



Fig. 1.

six times in every column. One of these inner designs was on all the cards to be learned. In the uni-inscribed series an inner design occurred only on the card that sounded the buzzer. Six different inner designs were used, each occurring once in every column. All the other cards in the uni-inscribed series had only outer designs.

In all three of these series each outer design, and in the duplico series each inner design, was on one of the correct cards in a series. While the same principle of distribution of outer designs was followed in all the series, the arrangement patterns were not identical for different series. A fourth series, a right-angled series, had no inner designs and had outer designs different from those of the other three series. Since the configurational characteristic, that is, the right-angled design, was inherent in the figure itself, the correct choice could not shift to different designs as in the other series. The designs were arranged so that each one occurred once in every column, but never in succeeding rows nor twice in the same row. Every time one of the right-angled designs occurred it was the correct choice. Learning this series by rote necessitated the memorizing of only six designs, while the other series required thirty if all the correct designs were memorized. Moreover, the character of concavity resulting from the making of all the angles ninety degrees gave the correct designs a general similarity of appearance in addition to the common configurational characteristic. To prevent the special conditions of this series from influencing the learning of the other series, the right angled series was learned last by all subjects. The spatial arrangement of the correct cards was different for each of the four series but constant for each series.

The cards for all series were exposed five at a time on a revolving drum. Five pairs of parallel copper wires, one pair behind each card, ran around the drum. The cards having designs that were to be learned had a piece of metal behind them. Pressure on the face of the card brought this metal in contact with the wires back of it causing a short circuit which sounded a buzzer.

As a form discrimination test the subject was first handed some cards from which he was asked to select those exactly alike. These included five cards having the single designs parallelogram, rectangle, pentagon, hexagon, octagon, and four with double designs, a pentagon and a parallelogram with horseshoe inner designs, and two pentagons with stars as inner designs. If a subject made a mistake (as a few did with the hexagon and octagon) in choosing designs other than the two with exactly the same configurations, he was asked if these were exactly alike and on his assent that they were not alike he was asked to point out the difference. No subject failed to point out the identical cards. The subject was then seated before the drum with five cards exposed. Directions were given orally, "Here are a lot of cards on this drum, thirty rows with five cards in each row. In every row there is one card that when pushed like a door bell (illustrating with the wand on a silent card, the fourth card row in 29) will cause a buzzer to sound. There are four cards in every row that will not make the buzzer sound. The buzzer sounds like this. (The experimenter reaches behind the screen and makes the buzzer sound.) Now I want you to learn which card it is that will make the buzzer sound in every row. (The subject is given the wand.) We will start with this row (turning to row 1). Look at all the cards and choose one to try. If it buzzes remember that it is the right one for that row and push it every time that row comes around. If it does not buzz, of course, you will want to press a different one when the row comes around again." One choice was allowed on each row in every revolution. When the first correct card was chosen he was reminded to press it every time that row came around, when the first wrong card was chosen he was reminded to press a different one when that row came around again. If after beginning the subject showed any indication of not understanding the problem he was again told, "In every row there is one card that buzzes. You may try any card. See how many buzzes you can get." No other information or encouragement

was given. Always beginning at row 1, the experimenter turned the drum through twelve revolutions at a sitting until thirty consecutive rows were passed without error. All choices were recorded by numbers according to rows and columns (see tables). Relevant spontaneous remarks were also recorded by the experimenter. Since the set-up did not provide for an accurate measure of time, the original plan was to measure learning in terms of revolutions only. Later a stop watch was introduced for obtaining the gross time per sitting. These supplementary data were recorded for some of the mentally deficient subjects and for all the normal subjects. Cards that became disfigured were replaced. The end of the wand was padded with soft paper which was frequently changed. When a subject came for succeeding series he was told that there were new cards on the drum but that one in each row buzzed as before and he was to learn which one it was in every row with these new cards.

The general procedure was to have subjects daily at approximately the same hour (excepting Saturday and Sunday) until a series was learned. While it was impossible to adhere to this program strictly, the exceptions were few.

Experimentation for data that were used in this study began with the duplico series in both institutions but there had been some preliminary work with several series at the Training School. Data were collected at the Training School from December 1932 to April 1933 and during the last two weeks of June 1933. Experimentation with the normal subjects was carried on from April 26 to June 15, 1933.

If the subject changed abruptly from relatively few successes to correct choices for a complete revolution and described the configurational characteristic, his use of it in learning was considered certain. In the absence of verbalization, the subject was given a test series having different designs but the same configurational characteristic as the learning series (see figure 1). While the subject waited out of view of the operations, the cards for the test series were placed over the cards on the

drum, beginning near the middle of the series, that is, about the fifteenth row. The experimenter then said, "Here are some more cards that belong to the same set. There was not room to put them all on at the same time. Try these." In exposing the test series the drum was turned in reverse order to its direction in the learning series to offset any effect of having learned the spatial pattern of the correct cards. When the subject had made one choice in each row of the test series, the drum was turned in its regular direction and the subject was asked for every row if he remembered which card he had chosen and why he chose it.

If the subject gave 100 per cent correct choices on the test series, or if he got more than 50 per cent correct and gave the configurational characteristic as the reason for these choices it was considered that he made use of it in learning the series.

It is obvious that the results on such an experiment could be influenced by communication of subjects. This was felt to be a particularly important consideration with the normal group not only because this group is more active and therefore presumably more communicative but also because the experimenter was new to the institution and the apparatus had aroused some curiosity. Arrangements were made with teachers for subjects in the same class to come in immediate succession with no opportunity for conversation. This safeguarded the first sitting of the normal subjects for the duplino series. Records at the beginning of subsequent sittings were compared with the last part of the preceding sitting. A decided difference in the number of successes on the last revolution of one sitting and the first revolution of the subsequent one was considered an indication of extraneous influence. When a subject voluntarily mentioned the configurational characteristic it was suggested to him that as different persons used different methods of learning neither the subject nor the experimenter would want to give his trick to another to use. The longer period of experimentation with the mentally deficient would seemingly favor the chances of communication in this group. The indications that the data on the duplino

series were not influenced by communication of subjects are summarized on page 27.

Results

Duplico Series

The duplico series was learned by some members of both groups before any other series, and by other members of both groups following other series.

Twenty-eight normal and twenty-four mentally deficient subjects learned the duplico series before learning any other series. The average number of revolutions required by the normal subjects was 43 ($\sigma=21.7$), for the mentally deficient group an average of 85 ($\sigma=43.7$) revolutions was required. The sigma of this difference is 9.8, giving a critical ratio of 4.3.

The relative difficulty of individual cards and of position in the series and in the row is approximately the same for the two groups. A comparison of the total choices expressed as percentages (see figure 2) shows a striking concurrence in the selections of the two groups.

Table I gives the chronological age, mental age (estimated from the most recent Stanford Binet), and the number of revolutions required by the subjects of both groups learning the duplico series before learning any other series. Results for subjects using the configurational characteristic and those learning by memory are placed in different columns. In this table and elsewhere in this study subjects designated by capital letters are boys. These results show a higher percentage of the normal subjects using the configurational characteristic and fewer revolutions required by the normals learning by memory. Since a reliability coefficient for this test cannot be obtained the short formula, the sigma of the difference of two means is the square root of the sum of the squares of the sigmas of the means, is applied to determine the significance of these differences. This was combined with Yule's formula for the standard deviation of percentages, the sigma of a percentage is the square root of the result when the percentage is multiplied by the difference between the percentage and 100 per cent and divided by the number of cases. Use of these two formulae,

A Comparison of the Total Choices of the Two Groups When These Choices Are Expressed as Percentages.

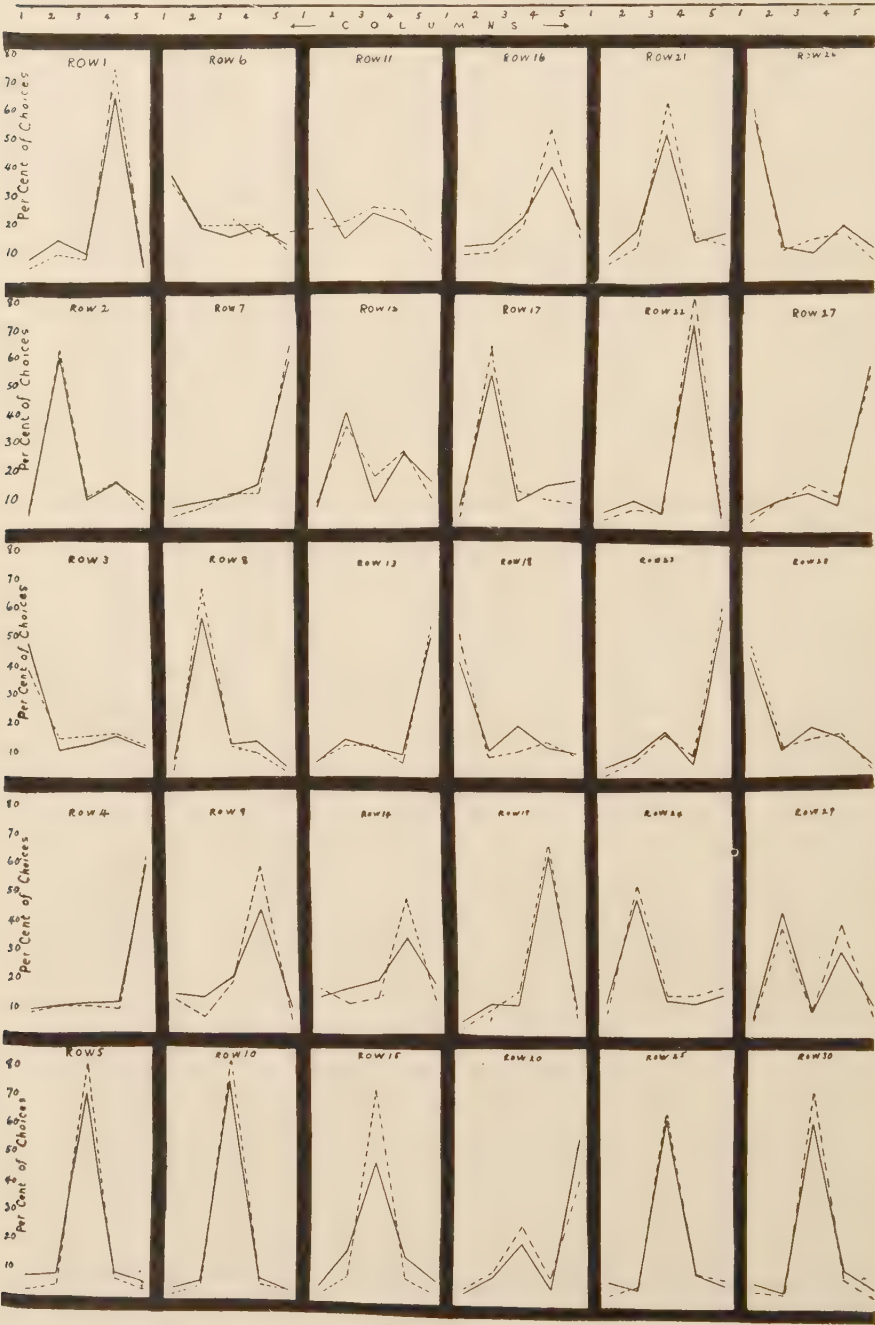


Figure 2

according to Garret's (9) tables, gives the following differences for all the subjects in table I.

Measure	N	MD	Dif.	SD of Dif.	CR	Chances of a true difference
Percentage using CC	68	21	47	12.1	3.9	100 in 100
Mean No. of revolutions when not using CC	62	99	37	10.6	3.5	100 in 100

CC indicates configurational characteristic, N the normal subjects, MD the mentally deficient subjects, CR the critical ratio.

When the comparison is confined within the same chronological age limits for the two groups the critical ratio of the difference in the percentages using the configurational characteristic is 3.6 and for the difference in the mean number of revolutions necessary for learning by memory 2.39.

A comparison within the same mental age limits shows a critical ratio of 3.7 for the difference in percentages using the configurational characteristic and more advantage to the normals in the mean number of revolutions required for learning the series by memory, but only three of the normals learning by memory are included in this comparison.

A comparison of the two groups with the mental ages of the mentally deficient corresponding to the chronological ages of the normal group includes all the mentally deficient subjects and the 14 youngest normal subjects in table I. The critical ratio for the difference in percentages using the configurational characteristic is 4.4 and the mentally deficient require more than twice as many revolutions as the three normals learning by memory.

Independent of the use of the configurational characteristic the normals have a faster rate of learning and show less negative acceleration as learning progresses. In an attempt to get a measure of the early rate of learning the number of revolutions required for getting twenty correct choices in a revolution was found for all subjects except those who obviously discovered the configurational characteristic before learning

TABLE I
Results of 28 Normal and 24 Mentally Deficient Subjects Learning the Duplico Series in Sequence One.

Normal Group					Mentally Deficient Group				
Sub.	C. A.	M. A.	No. of Revolutions Not Using		Sub.	C. A.	M. A.	No. of Revolutions Not Using	
			Using CC	Using CC				Using CC	Using CC
	....	....	..	....	mb.	9-10	6- 7	..	140
	....	....	..	....	sc.	10- 9	7- 0	..	141
	....	....	..	....	mc.	10-11	7- 3	..	127
	....	....	..	....	RC.	11- 0	7- 3	..	112
GP	8- 0	7- 6	19	....	GB	11- 2	7- 7	..	95
FB	7-11	7- 9	..	43	jc.	13- 4	8- 2	..	85
dg	8- 9	8- 2	61	....	FC	13- 6	8- 5	..	84
gp	8- 6	8- 5	28	....		....	....	..	....
BP	7- 5	8- 5	..	48		....	....	..	....
mtb ...	9- 7	9- 1	43	....	DB	12- 9	8- 7	..	97
vl	9- 9	9- 3	34	....	AC	14- 3	8- 7	..	42
HS	9- 5	9- 5	..	51	HB	14- 6	8- 8	..	84
	....	....	..	....	SA	13- 0	8- 9	..	55
	....	....	..	....	RD	14- 0	9- 1	35	....
ms	9- 7	9- 6	48	....	HC	13-11	9- 7	17	....
dd	9- 8	10- 1	25	....	HF	21- 1	9- 8	..	174
EN ...	12- 8	10- 4	16	....	LDB ..	15- 8	9- 9	81	....
ET	8-10	10- 5	36	....	bc.	14- 5	9-10	..	96
	....	....	..	....	CC ...	15- 1	9-10	..	72
	....	....	..	....	JL	16- 2	9-11	..	40
	....	....	..	....	brc ...	18- 7	10- 1	..	141
	....	....	..	....	GOB ..	16- 3	10- 5	..	108
HV ...	9- 7	10- 6	22	....	ed	17-10	10- 7	36	....
AL	12-11	11-4	53	....	jsz	15-10	10- 9	..	42
	....	....	..	....	NC	17- 0	10- 9	11	....
	....	....	..	....	HAC ..	16- 0	10-11	..	120
WG ...	11- 0	11- 8	24	....		....	....	..	....
RS	11- 0	11- 9	58	....		....	....	..	....
RM ...	11- 7	11-10	17	....		....	....	..	....
RP	12- 3	12- 2	..	64		....	....	..	....
WN ...	13- 5	12- 2	36	....		....	....	..	....
NL ...	13- 8	12- 7	63	....		....	....	..	....
gg	13- 2	13- 0	..	76		....	....	..	....
JH	14- 5	13- 8	..	106		....	....	..	....
gm	18- 5	14- 8	9	....		....	....	..	....
dj	14- 3	14-10	12	....		....	....	..	....
HI	15- 1	15- 0	..	70		....	....	..	....
GW ...	17- 0	15- 6	..	44		....	....	..	....
FR	16- 1	15- 8	..	52		....	....	..	....
mr	14-10	15-10	36	....		....	....	..	....
Av. ...	11- 9	11- 5	34	62	Av. ...	14- 5	9- 1	36	99

The record of one mentally deficient subject who was obviously "tipped off" between the first and second sitting is not included.

twenty cards. Since six correct choices could be made by chance in each revolution, indices of rates of learning were found by dividing fourteen by the number of revolutions required for getting twenty correct choices in one revolution. Figure 3 gives the distribution of the two groups on these indices, showing the superiority of the normals in rate of learning prior to the discovery of configurational characteristic.

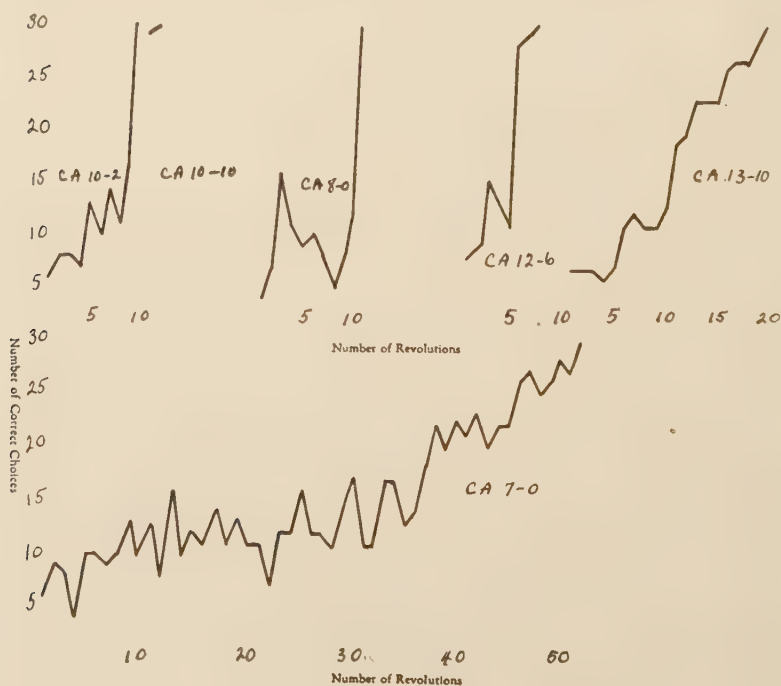
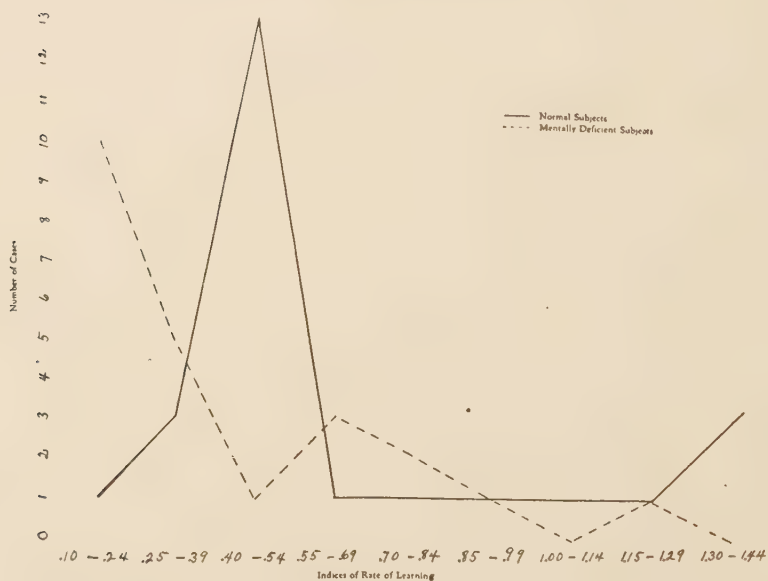
Although the normals, on an average, were decidedly superior in learning as measured by the number of revolutions required, some of the faster learners in the mentally deficient group required approximately the same number of revolutions for learning as some of the normals. A comparison of these curves (see figure 4) shows that the mentally deficient do relatively more of their learning in the earlier revolutions with marked negative acceleration as learning progresses.

The curves of the six superior girls (see figure 5) may be characterized as exaggerating the deviations of the normals from the mentally deficient subjects. There is a high percentage of use of the configurational characteristic, all but the seven-year old subject having made use of it, a rapid rise in the learning curve prior to the discovery of the configurational characteristic, and no flattening out tendency near the end of the curve of the one subject learning by memory.

The preceding tables and curves take no account of the wrong choices. These choices probably reveal more about the learning process than the right ones. The record of no subject gives a random distribution of these incorrect choices. In fact, the responses are characterized by persistence in certain errors. The record of the first two sittings of subject gp on the duplico series is given in tables II and III. In these tables the choices are given in numbers corresponding to the columns (numbered from left to right) of the duplico series (see figure 1). Correct choices are indicated by c. The number of the column of the correct card in each row is given immediately at the right of the row number. There are fifteen occasions on which subject gp chose the same wrong card on six or more consecutive revolutions, in one case choosing the same wrong card in eighteen consecutive revolutions. The

Rates of Learning Prior to Use of the Configurational Characteristic.

Fig. 3.



Learning Curves of Six Superior Girls.

Fig. 5.

A Comparison of the Curves of Normal and Mentally Deficient Subjects Requiring Approximately the Same Number of Revolutions for Learning the Duplo Series

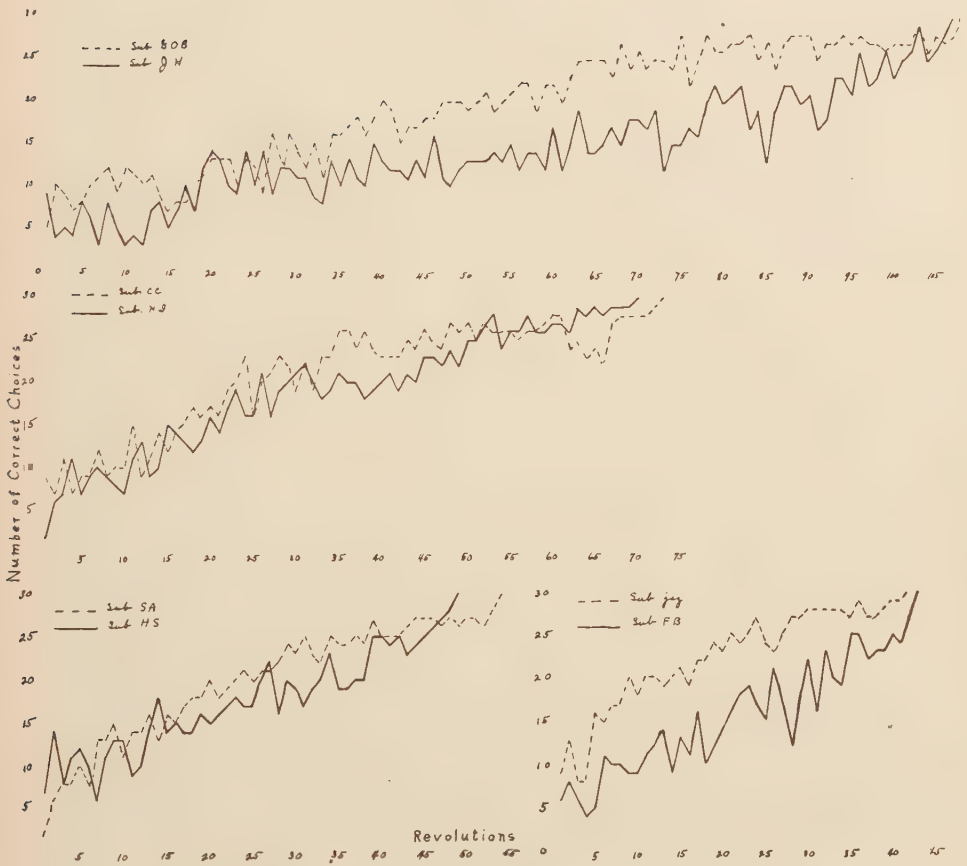


Fig. 4.

relatively high learning rate of this subject makes this phenomenon all the more interesting.

When the choices are tabulated by sittings (see table IV) the succession of choices cannot be followed as in tables II and III but persistent preference for certain wrong cards is evident in all the records and the shifting from one preference to another is clear in many cases. The numbers in this table indicate how many times the card in the row and column designated was selected in each sitting. A pure chance distribution allows not more than three choices to any one card in a sitting. While the expectancy of an equal distribution would be low, with so few selections, the tendency of making like choices in succession adds to the significance of the number of choices.

Since every design appears once in every column during the series and there are six cards sounding buzzers in every column it might be expected that the same number of choices would fall in each column. Neither group shows such a distribution. Of the choices shown graphically by percentages in figure 2 the most are made in the center column and fewest in the first by both groups. The mentally deficient group shows a greater difference, taking 16,572 choices in the center to 8,089 in the first column, while the normals take 8,529 in the center to 5,289 in the first column.

The general appearance of the data suggests a greater tendency on the part of the mentally deficient to prefer certain cards. For investigating this possibility all the wrong responses of the subjects in table I were tabulated according to length of uninterrupted sequences, that is, the number of successive revolutions on which the same wrong card was chosen. The sequence was considered ended if a right or a different wrong choice was made. The shortest sequence would, of course, be one. The longest sequence was found to be forty-six. The per cent of wrong choices for each sequence length was recorded for every subject and the means of these per cents found for the two groups are as follows:

	Length of Uninterrupted Sequences of Wrong Choices								
	1	2	3	4	5-6	7-10	11-15	16-25	25-46
MD	44	22	11	7	7	6	3	1	1
N	50	23	10	5	6	4	2	1	0

TABLE IV.
Record of Sitzings of bc Learning the Duplico Series First.

Sit- tings	ROWS														
	1					2					3				
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TABLE IV—Continued.

Sit- tings	ROWS																												
	11					12					13					14					15								
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
Columns																													
1—0	2	4	..	6		1	7	..	..	4	7	3	..	1	1	9	..	3	0	..	..	1	0	8	3				
2—0	2	6	4	..		..	10	..	1	1	2	6	1	3	0	6	1	1	3	1	..	2	3	..	7				
3—1	1	2	8	..		..	4	3	2	3	2	4	4	2	0	2	2	..	6	2	..	..	12	..					
4—3	4	3	2	..		..	4	3	4	1	2	5	1	4	0	..	2	..	10	..	..	..	12	..					
5—0	1	1	9	1		..	1	2	8	1	..	6	..	1	5	..	2	..	10	..	..	..	12	..					
6—1	1	3	7	..		..	6	3	3	..	..	..	..	..	12	..	..	..	12	..	..	..	12	..					
7—8	..	3	1	..		..	12	..	..	..	..	..	..	..	12	..	..	..	12	..	..	..	12	..					
8—12	..	..	..	..		..	12	..	..	..	..	..	..	..	12	..	..	..	12	..	..	..	12	..					
25 11 22 31 7					1 56 11 18 10					13 24 6 11 42					17 7 4 65 3					0 3 75 8 10									
16										17					18					19					20				
1—..	3	..	0	9		..	0	2	1	9	0	5	6	..	1	..	1	5	5	1	1	1	9	..	1				
2—1	1	4	2	4		..	3	1	2	6	2	2	8	..	..	1	1	4	6	..	1	7	1	1	2				
3—2	3	1	6	..		1	2	3	5	1	5	..	6	1	..	..	1	3	8	..	..	8	..	2	4				
4—2	..	2	8	..		..	1	9	2	..	11	..	1	..	..	..	1	2	9	..	1	5	..	2	4				
5—..	1	1	10	..		..	4	8	..	..	12	..	..	..	..	..	..	..	12	..	1	2	3	..	6				
6—..	1	1	6	4		..	11	1	..	..	12	..	..	..	..	..	..	..	12	..	..	..	..	12					
7—..	..	..	9	3		..	12	..	..	..	12	..	..	..	..	..	1	11	..	..	..	..	1	11					
8—..	..	..	..	12		..	12	..	..	..	12	..	..	..	..	..	..	..	12	..	..	..	..	..	12				
5 9 9 53 20					1 45 24 10 16					66 7 31 1 1					1 4 15 75 1					4 23 13 4 52									

Correct Choices are in Italics.

TABLE IV—Continued.

Sit- tings	21					22					ROWS 23					24					25				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Columns																									
1—	2	5	2	3		..	1	..	11	..	3	..	5	..	4	3	6	1	..	2	1	..	0	..	11
2—	..	10	1	1		..	..	..	12	..	..	1	9	1	1	3	3	2	1	3	4	1	1	..	6
3—	..	12	..	..		..	..	..	12	..	..	..	9	3	0	1	4	2	3	2	2	..	8	1	1
4—	..	12	..	..		..	..	..	12	..	..	3	3	2	4	..	9	1	2	..	..	1	11	..	..
5—	..	12	..	..		..	..	..	12	..	..	..	2	..	10	..	10	1	..	1	..	..	12	..	..
6—	..	11	..	1		..	..	..	12	..	..	..	1	..	11	..	12	..	..	..	1	3	8	..	..
7—	..	12	..	..		..	..	..	12	..	..	..	..	..	12	..	12	..	..	..	..	1	11	..	..
8—	..	11	..	1		..	..	..	12	..	..	..	..	..	12	..	12	..	..	..	..	..	12	..	..
0	2	8	5	3	6	0	1	0	9	5	0	3	4	2	9	6	5	4	7	6	3	8	6	6	3
26	27					28					29					30									
1—	9	..	..	3	..	2	..	1	9	0	0	2	2	7	1	9	0	..	3	..	..	..	5	7	..
2—	5	3	..	3	1	..	..	6	6	0	0	4	3	5	..	9	1	..	2	..	..	3	6	3	..
3—	6	2	1	2	1	..	1	4	6	1	0	3	5	3	1	4	0	2	3	3	..	1	10	1	..
4—	1	2	2	2	5	..	1	8	2	1	3	1	4	3	1	1	0	5	2	4	1	..	11	..	..
5—	7	1	2	..	2	..	3	3	4	2	2	3	1	6	..	..	2	..	9	1	..	..	12	..	..
6—	12	..	..	..	..	..	..	..	..	12	8	1	1	2	..	..	0	..	11	1	..	..	12	..	..
7—	12	..	..	..	..	..	..	..	..	12	10	..	..	2	..	..	0	1	9	2	..	..	12	..	..
8—	12	..	..	..	..	..	..	..	..	12	12	..	..	..	..	..	8	..	4	..	5	1	1	5	..
64	8	5	10	9		2	5	22	27	40	35	14	16	28	3	23	12	8	42	11	6	5	68	16	0

Correct Choices are in Italics.

The normals show a higher percentage of wrong choices in short sequences but the differences are slight. The greatest difference is found in the two groups on the single wrong choices. This difference of 6 in the means has a standard deviation of 10.6 showing that even this difference is not reliable. The variation of the normal group on the percentage of single wrong choices is greater (σ of Dis.=8.7) than that of the mentally deficient group (σ of Dis.=6.1) probably because of the greater percentage of the normals discovering the configurational characteristic early enough to prevent long sequences of wrong choices.

The decided apparent difference is chiefly due to the longer time required by the mentally deficient for the recognition of a wrong choice. The length of these preferences are proportional to the length of the learning records of the two groups.

In order to get some measure of the relative influence of chronological age, mental age, and I.Q., all of the subjects who learned the duplico series in sequence one were ranked in each of these respects and on the number of revolutions required for learning the series. In addition to the subjects listed in table I there were nine boys with an I.Q. range of 75-90, and five girls with an I.Q. range of 113-124. Spearman's rho formula gives a correlation with speed in learning (as measured by the number of revolutions required) of $-.12$ ($\sigma=.13$) with chronological age of $.36$ ($\sigma=.11$) with mental age, and of $.55$ ($\sigma=.09$) with I.Q. Since no normal or superior subjects below the eighth chronological year level (7 years 6 months) and no mentally deficient subjects below the ninth year mental level discovered the configurational characteristic, these subjects may have influenced the above correlations unduly. Without these subjects speed in learning correlates $-.11$ ($\sigma=.14$) with chronological age, $.03$ with mental age, and $.46$ ($\sigma=.10$) for I.Q. While the correlation with I.Q. is the only significant one of the three it is lower than might have been expected from the differences obtained between the two groups. This is possibly due to the limited I.Q. range of the

two groups which include most of the subjects ranked. There are no significant correlations within either of these two groups, nor with chronological age in any grouping or ranking of subjects. The coefficient of mean square contingency for normal intelligence and use of the configurational characteristic is .44.

Results on the Duplico Series Learned Following the Learning of Other Series

Twenty-one normal and eleven mentally deficient subjects learned the duplico series after using a configurational characteristic in learning one or more other series¹. When all the subjects are included (see table V) the two groups show the following difference in the percentages making use of the configurational characteristic:

Measure	N	MD	Dif.	SD of Dif.	CR	Chances of a true difference
Percentage using CC	95	36	59	15.3	3.9	100 in 100

Only one normal subject learned the series by memory. Limiting the two groups to the same mental age excludes the one normal subject learning by memory which increases the difference ($C R = 4.4$) but this comparison is based on only eight normal and eleven mentally deficient subjects.

Learning the duplico series first is more difficult, as measured by the number of revolutions required and the percentages using the configurational characteristic, than learning it after having used a configurational characteristic in other series. More difference in success is seen in the normals than in the mentally deficient subjects when learning in different sequences. The advantage of sequence (2) over sequence (1) is shown by the following comparison of homogeneous groups from tables I and V.

1. In addition two mentally deficient girls with incomplete records failed to use the configurational characteristic during twelve revolutions.

TABLE V.

Results on Learning the Duplico Series after Using the Configurational Characteristic in Learning One or More Series.

NORMALS					MENTALLY DEFICIENT				
Sub.	C.A.	M.A.	No. of Revolutions Not		Sub.	C.A.	M.A.	No. of Revolutions Not	
			Us- ing cc	Us- ing cc				Us- ing cc	Us- ing cc
GF (4)	8- 0	7- 7	4	..		....	....	..	..
ah (2)	7- 6	7-11	1	..		....	....	..	..
AP (3)	8-10	8- 8	12	..	eb (4)	13- 7	8- 8	19	..
MH (2)	8- 9	9- 1	4	..	CB (2)	15- 3	9- 4	8	..
	....	....	..	..	mad (2)	13- 1	9- 4	..	86
	....	....	..	..	VB (4)	15- 5	9- 5	2	..
EP (4)	10- 0	9- 7	7	..	AA (4)	14- 0	9- 6	..	68
mab (4)	8-10	9- 7	11	..	PA (2)	17- 1	9- 9	..	87
PM (4)	9- 7	9- 9	3	..	GA (4)	15- 1	9- 9	18	..
jh (3)	12- 4	10- 4	24	..	ab (4)	18- 8	10- 1	..	55
	....	....	..	..	ma ^a (2)	18-11	10- 3	..	102
	....	....	..	..	LB (2)	15- 6	10- 4	..	72
DL (2)	11- 2	10-11	4	..		....	....	..	..
AH (2)	11- 3	11- 0	7	..	mib (4)	15-10	10-11	..	108
PF (3)	10- 3	11- 8	1	..		....	....	..	..
TL (4)	12- 8	11-11	3	..		....	....	..	..
GS (3)	12- 5	12- 0	2	..		....	....	..	..
DF (3)	13- 4	12- 5	3	..		....	....	..	..
EP (4)	13-10	13- 3	13	..		....	....	..	..
CF (4)	14- 9	13- 7	..	63		....	....	..	..
RE (4)	13- 0	13- 9	4	..		....	....	..	..
GY (4)	16- 3	14- 5	2	..		....	....	..	..
ht (2)	15- 2	14-10	2	..		....	....	..	..
NV (2)	15- 5	14-11	8	..		....	....	..	..
RM (4)	14- 5	15- 2	7	..		....	....	..	..
Av. ...	11- 9	11- 6	6	63	Av. ...	15- 8	9- 9	12	83

The numbers in parentheses indicate the sequence of learning the duplico series.

Measure	N. Group		Diff.	S.D. of Diff.	C.R.	Chances of a true difference
	Seq. (1)	Seq. (2)				
Mean No. of Rev. when using cc	34	6	28	3.9	7.2	100 in 100
	M.D. Group					
	Seq. (1)	Seq. (2)				
	36	12	24	11.7	2.1	98 in 100
	N. Group					
	Seq. (1)	Seq. (2)				
Mean No. of Rev. when not using cc	62	63 one case		Not enough cases for comparison		
	M.D. Group					
	99	83	16	10.6	1.5	93 in 100
	N. Group					
Percentage using cc	Seq. (1)	Seq. (2)				
	68	95	27	10.0	2.7	100 in 100
	M.D. Group					
	Seq. (1)	Seq. (2)				
	21	36	15	13.7	1.1	86 in 100

Time

With the rough measure of time used only distinct variations have significance. The average time per sitting was 24 minutes for the mentally deficient and 22 minutes for the normals. Both groups had wide variations. Immaturity and the mode of attack on the learning problem were apparently important factors in time variation. The 9-year-10-months old mentally deficient girl, the 7-year-5-months old normal boy and the 7-year old superior girl took decidedly more time, each averaging about 40 minutes per sitting. An attack favorable to discovery of the configurational characteristic was more time consuming per revolution than an attack unfavorable to its discovery. The subjects (regardless of group placement), who used the configurational characteristic averaged about 3 minutes per revolution while subjects not using this characteristic averaged slightly under 2 minutes per revolution. Deliberation was most apparent in the attack of subjects who had used a configurational characteristic in learning a previous series. Subject VB (table V) took six minutes for his first

revolution of the duplico series. The shortest time reaction is found in the records of subjects who were apparently trying to locate an arrangement pattern of the cards sounding the buzzer. Such an attack was evidenced by frequent placement of the wand before exposure of the cards and in the reasons given for choices on the test series. This tendency was very marked in the normal subject JH (table I) who averaged 16 minutes per sitting. For her first sitting the mentally deficient subject bc took 65 minutes, but gradually decreased her time in subsequent sittings to 25 minutes.

There were also variations of time in individual choices. There was frequently overt vacillating between cards. After choosing the same wrong card several times in succession the subject had a tendency to pause when coming to that row, usually shifting to a new preference.

Age and Sex Differences

Beyond the level at which success begins, neither chronological nor mental age seems to contribute measurably to success in learning the duplico series. With the subjects used in this experiment no normals below the age of eight and no mentally deficient below the 9 year mental level were successful in using the configurational characteristics in the duplico series in sequence (1). Unfortunately, very few normal or superior subjects of ages 7-8 were available and none between 6 and 7. Two mentally deficient subjects with mental ages between 5 and 6 were discontinued after the first sitting because of their apparent inability to set learning as a goal. One subject followed the same column for 12 revolutions in spite of repetitions of the directions. Two or three revolutions seemed to be the limit of the other's perseverance.

No consistent sex differences appear in the results. The girls in the normal and the boys in the mentally deficient group have slightly better records. As a whole the two sexes show about the same variations.

Summary of Results on the Duplico Series

The learning of the duplico series is easier for normal than for mentally deficient children of the same chronological or

mental age. The difference between the two groups is statistically reliable for the percentages making use of the configurational characteristic and the number of revolutions necessary for learning the series by memory.

Above the eighth chronological year in the normal and the nine year mental age in the mentally deficient, neither mental nor chronological age is an important factor in learning the duplico series.

The few bright subjects learning the series were more successful than the normal.

Differences in time reaction seem to be due, largely, to factors other than intelligence. Subjects using the configurational characteristic took more time per revolution than subjects not using it, i.e., use of the configurational characteristic and deliberate choosing seemed to go together. Subjects below 8 years in mental or chronological age required more time per sitting. Seeking a spatial arrangement of correct cards was conducive to rapid choosing, at least, the two factors went together.

No chance distribution of choices is found. All subjects showed preference for particular cards and both groups made most choices in the center column and fewest in the first column. Choosing the same incorrect card on successive revolutions is more apparent in the records of the mentally deficient subjects but when all the wrong choices of the subjects, normal and mentally deficient, are tabulated according to the length of uninterrupted sequences there are no reliable differences between the two groups in the mean percentages of wrong choices of different sequence lengths.

The duplico series is easier for both normal and mentally deficient subjects after they have used a configurational characteristic in learning another series. The improvement of the normals in the percentage making use of the configurational characteristic, and in the number of repetitions necessary for learning is statistically reliable. The mentally deficient show improvement greater than chance in the percentage making use of the configurational characteristic and in the number of

revolutions necessary for learning with and without use of the configurational characteristic.

Examination of these results indicates that the data included were not influenced by communication of subjects regarding the configurational characteristic. Only one mentally deficient subject succeeded in learning the duplico series during the first sitting. The one subject who jumped from a few successes on the first sitting to complete success at the beginning of the second sitting was dropped and no more subjects were taken from his immediate associates. The remarks of the two normal subjects learning during the first sitting, after 9 and 12 revolutions, respectively, indicated that discovery of the configurational characteristic was entirely spontaneous. No normal subject showed a marked change in success on the last revolution of one sitting and the first revolution of the subsequent sitting. There are two indications from the data themselves that the differences between the normal and mentally deficient groups were not inflated by indirect information, i.e., knowledge on the part of the normals that there was some kind of trick in learning the series. Such a knowledge should make learning the duplico series in sequence (1) comparable to learning it in sequence (2). There is a statistically reliable difference in the mean number of revolutions necessary for the normals learning the duplico series in sequence (1) and in sequence (2). Furthermore, the normal subjects show more transfer from learning a preceding series with use of a configurational characteristic than do the mentally deficient subjects. The normals show more improvement in the percentage making use of the configurational characteristic as well as in the number of revolutions necessary for learning the series.

Idem Series

Both groups found it easier to learn, selectively, geometric designs having an identical element, as presented in the idem series, than those whose common configurational characteristic was an inner design like the outer design, as presented in the duplico series. The normal group was more successful in learning the idem series regardless of the sequence of learning.

With the number of subjects used, no differences are statistically reliable. The normals show the greatest advantage when learning the idem series following the duplico series and the least when learning it before having learned any other series.

Uni-inscribed Series

The uni-inscribed was the easiest of the three series for both groups. The normals required, on the average, slightly more than one revolution and the mentally deficient slightly more than two revolutions for learning this series following the learning of the idem series. It was more difficult for both groups when learned first or learned following the duplico series. Only fifty per cent of the mentally deficient subjects made use of the configurational characteristic when learning this series following the duplico series. Only seven per cent of the normal subjects failed to make use of the configurational characteristic regardless of the sequence.

Right-angled Series

The right-angled series was the last one learned by all who had it. With only six designs to be learned it is obvious that this series would be much easier to memorize than those in which the cards sounding the buzzer had 30 wholly or partially different designs. Besides having fewer designs sounding the buzzer, selection of the correct cards in this series was made easier by the concavity similarities necessitated by making all the angles of the correct designs 90 degrees. This similarity factor probably explains the gradations in success on the test series. A comparison of percentages of success and the number of revolutions necessary for learning (for 45 normal and 23 mentally deficient subjects) is given below.

Measure	N.	M.D.	Diff.	S.D. of Diff	C.R.	Chances of a true difference
Mean No. of Rev.'s for learning	3	6	3	1	3	100 in 100
Mean percentage of success on test	75	54	21	7.4	2.8	100 in 100

Both measures of success favor the normals with statistically reliable differences. When the records of the five mentally deficient subjects who failed to use the configurational characteristic in the three preceding series are omitted, the differences between the two groups in the mean number of revolutions required for learning the series disappears, and the difference in the percentages making use of the configurational characteristic is decreased.

Summary of Results

The results of this experiment indicate that normal subjects surpass mentally deficient subjects of the same chronological or mental age both in the use of a common configurational characteristic in learning a series of geometric designs and in learning the series by memory.

The duplico and right-angled series show differences between the normal and mentally deficient groups that are statistically reliable. The idem and uni-inscribed series have insufficient data for showing reliable differences between the groups. The greatest differentiation between groups is found on the most difficult series, the least on the easiest series. Since the data showing the most differentiation were the earliest taken on both groups the probability of extraneous influence is lower than for the data recorded later.

The order of decreasing difficulty of the rotated series is duplico, idem, uni-inscribed as measured by the number of repetitions necessary for learning. Because of its difference in construction and learning sequence the right-angled series cannot be included in this comparison.

Sequence of learning a series influences its difficulty. The duplico series is easier for both normal and mentally deficient subjects when it is preceded by one or both of the idem and uni-inscribed series but the normals show more transfer than the mentally deficient from learning the preceding series. The idem and uni-inscribed are each easier for the two groups when preceded by the other but more difficult when preceded by the duplico series with the exception of the idem series for the normals. The normals find it slightly easier to learn the

idem series following the duplico than to learn it before any other series.

Preferences for particular cards and positions are practically the same for the two groups but the longer learning period of the mentally deficient tends to exaggerate these preferences. Both groups have decidedly more than chance repetition of errors. The records of the mentally deficient subjects show more long runs of the repeated wrong choices but the mean percentage distributions on length of runs show no reliable differences for the two groups.

Beyond a certain level of maturity, approximately the eight year level in the normal and the nine year mental age level in the mentally deficient subjects of this group, neither mental nor chronological age contributed to success as measured by the number of revolutions necessary for learning the duplico series. Intelligence, as measured by I.Q. was a factor contributing to success.

No consistent sex differences are found for the subjects of this experiment.

When using the configurational characteristic the normal and mentally deficient subjects have approximately the same average time per revolution. When learning by memory the normals average slightly less time per sitting than the mentally deficient.

Interpretation of Results

Since there were more data with more differentiation of groups on the duplico series most of the interpretations are based on the records for this series.

It can be seen in table I, table V and figures 3 to 5 that the superiority of brighter subjects is manifested by more rapid learning, a higher percentage using the configurational characteristic, less slowing up in the rate of learning, and more transfer to other series. A close study of the records suggests that these advantages come from a more closely integrated reaction pattern.

A sharper discrimination as to relevancy gives the response pattern of the brighter subjects a character of self-motivation largely lacking in the responses of the mentally deficient. This

difference in spontaneous motivation is brought out by the contrasting remarks of the slowest learner of the superior subjects and the slowest learner in the mentally deficient group. Subject sh (C.A. 7-0, M.A. 8-8) was frankly bored the first two sittings of the experiment, remarking at the end of the first sitting, "I wish I didn't have to come back but I know I will." Nevertheless, the remarks of sh throughout the experiment were markedly self-critical. In the sixth revolution, after having taken the same wrong card in the four preceding revolutions, she made a different wrong choice remarking, "Well, at least I didn't push that one," pointing to her previous choice. Several times in choosing a wrong card in a row on which she had previously made a right choice she said, "I forgot to look over the cards." "I press that one every time," was often remarked, after the repetition of a wrong choice. Statements such as "I'm not going to forget this time to look over the cards," "I forgot and I said I wasn't going to," "I'm going to look with my eyes next time," indicated recurring motivation with the outcome of selections. Subject HF (C.A. 21-0, M.A. 9-7) graciously gave his time for experimentation and finished each of his fifteen sittings with a bland smile of self-satisfaction. His remarks reflected this complacent attitude. "I'm catching on now, at first I didn't know which ones to push." "I don't know why but I can always do things like this." There were also irrelevant remarks concerning his privileged status in the institution but never was there any questioning of the effectiveness of his mode of responses.

The normal subjects gave more indication of checking up on themselves than did the mentally deficient. Five normal subjects after making some progress counted the successive buzzes. No counting was indicated by the mentally deficient subjects but three did offer inaccurate estimates as to how many buzzes they had found. A normal subject, BP, after getting several buzzes in succession, remarked, "Now I'm going right back to that square one without missing." On the other hand mentally deficient subject, LDB, whose average correct choices per revolution on the third sitting was one

greater than chance, frequently remarked on pushing a correct card during this sitting, "I am great. Eric the Great."

Rapid learning and use of the configurational characteristic seemed to be closely related. The subjects using the configurational characteristic were more deliberate in choosing. Taking note of the characteristics in general naturally facilitated discovery of a common one. In some cases the factor of similarity apparently affected the rate of learning before the subject was aware of its effectiveness. Subject eh (see figure 5), whose learning was very rapid, said at the end of the first sitting, "One is a triangle in a big triangle, one is a kettle in a big kettle and one is a circle in a big circle." Another of the superior subjects remarked, "It seems to me that quite a few now have had the outside like the inside," before she carried it out consistently. Subject dg, whose learning curve rose regularly, remarked when learning was almost complete, "I know which ones to choose now, the ones I like the best like those," pointing to a correct design. The rate of learning and the spontaneous remarks of the mentally deficient subjects using the configurational characteristic were comparable to those of the normals who used it.

Decline in the rate of learning and little transfer from one series to another are probably manifestations of weakness in integrating the responses. The tendency of the mentally deficient to show a decline in the rate of learning is apparently independent of the rate itself. There were four mentally deficient subjects (AC, SA, JL, and jsz) learning by memory whose rate compared favorably with the learning rate of the normals. Their curves, however, show more negative acceleration (see curves of SA and jsz in figure 4). The spontaneous remarks of these subjects reveal little about their methods of learning. JL did not speak during any sitting. When asked for the reason of choices in the test series he replied, "My eyes go that way." The other three remarked once or more that they had tried every card in particular rows and none of them buzzed. The only remark approaching a generalization was AC's statement that, "It seems like they are all on the ends." JsZ said on row 29, "I always remember that Christmas tree."

The most revealing remark was jsz's that, "It seems like I can just picture how these look." Both SA and jsz on being confronted with the test series exclaimed that they would be unable to get any right. Excepting the mention of localization, these remarks indicate no progression beyond consideration of choices as discrete events. Less inclination to tie experiences together probably accounts for the mentally deficient improving less than normals from having learned another series (see table V).

The above differences according to intellectual ratings are similar to those pointed out by Sullivan (19) in her study of attitude in relation to learning. She found the difference of age less important for intellectual generalization than the factor of brightness, a higher correlation between success and intelligence when generalization was the set task, and evidence of generalization from the beginning if it took place at all.

Bacher (1) on the basis of his results with the Achsche Suchmethode on two groups similar to the groups of this study attributed the difference to a weakening of the determining tendency in the mentally deficient. The data of this experiment indicate that the difference is due more to gain on the part of the normal and superior subjects with progress in the experiment than to loss on the part of the mentally deficient subjects.

The failure of subjects BP (C.A. 7-5, M.A. 8-5) and sh (C.A. 7-0, M.A. 8-8) to use the configurational characteristic in the duplico series although they learned by memory as easily as older subjects, raises the question of whether ability to see such a relationship develops suddenly about the eighth year in normal and superior children. Neither used the configurational characteristic in learning the duplico and idem series but BP did in learning the uni-inscribed series, although he required four revolutions more for learning than sh who learned it without realizing there was a common characteristic in the correct designs. The comments of sh on the uni-inscribed series were very interesting. On the first exposure she exclaimed "There's just one of 'em has a middle." The number of correct choices per revolutions was 11, 17, 19, 19, 28, 30.

While the experimenter was putting the test series on the drum she said, "I can't catch on. I never can. I just memorize 'em. After I learned the first one A tried to explain it to me but I couldn't understand it." Four out of ten choices on the test series were correct but no reason was given. Unfortunately no other normal or superior subjects of this age were available. On a preliminary experiment a superior five year old girl failed to learn in 60 trials with two cards that a box of candy was always behind the card with a triangle on it.

Since none of the mentally deficient subjects below the nine year mental age level and few at and above that level used the configurational characteristic in learning the duplico series (see table I), the results of this experiment suggest that mentally deficient subjects are not comparable to normal subjects of the same mental age in propensity to learn by similarities and relationships. This ability apparently appears at a higher mental age in the mentally deficient and is less in evidence beyond that level than in a normal group of corresponding mental age.

This seemingly sudden maturation of the perception of sameness has been noticed in other experiments. Hazlitt (12) in studying young children found that very few children could pick out the common element when the same toy object was presented with a different toy successively on four trays. The children were asked, "What have all the trays got?" Hazlitt concluded from the results that "the realization of sameness in difference is an experience that comes more or less suddenly to the child, and that in some it does not come much before three years." Further experimentation indicated that the older the children the narrower the bases chosen for their generalizations. In experimenting with normal and mentally defective children in building up word concepts from objects having common characteristics Bacher found a rapid change in normal children during the ninth year. While the mentally deficient subjects were all over 9 years old their behavior was not superior to that of 7-8 year old normal children who tended to make intellectual decisions from the concrete to the more concrete. In discussing the child's formation of con-

cepts Wheeler and Perkins (21) state (probably on the basis of the Binet Scale), "He is able to recognize differences between objects sooner than he is able to recognize similarities. The latter process must wait upon further maturation, which appears from the eighth or ninth year on." It is interesting to note that subject sh, mentioned above, immediately recognized that one card in each row of the uni-inscribed series was different from the others but apparently never realized the similarity in these cards that were different.

The records of choices offer an interesting study of the process of selective learning. No record shows a haphazard pushing of cards until the right ones are discovered and retained. The totals of choices for different positions show the fallacy of assuming that all the choices in a selective situation are equally probable. In spite of the fact that every design appears once in the series in every column, the three center columns are decidedly preferred by both groups to the first and fifth columns. Some of the preferences for particular cards have plausible explanations such as the similarity of the fourth card in row 29 to the right card in row 7 (see figure 1) but the variety of patterns of preference and the consistency of the subjects in following seemingly organized sequential preferences suggests that subjects follow a series of "hunches" in learning selectively.

The repetition of errors so evident in the data of this experiment is by no means a new phenomenon. It is characteristic of the reaction of animals in a multiple choice situation. Psychological interpretations of this phenomenon have varied from Thorndike's (20) doctrine that repetition strengthens a physiological connection to Dunlap's (7) Beta postulate with the suggestion of voluntary following of incorrect paths as a method of breaking down fixations. Yerkes (25) and Hamilton (10, 11) have observed various types of animals, including humans, in multiple choice situations with a view of classifying them according to mental organization. Krechevsky (14, 15) contended that the tendency of the rat to build up a systematic series of responses rather than to display helter-skelter

unorganized trial and error responses indicates the genesis of hypotheses.

Responses on this experiment show types of attack on the problem as a whole with definite position and card preferences from the beginning. The most naive attack was that of following one column only. One mentally deficient subject, mentioned on page 25, used this attack for 12 revolutions. Subject mb started out with a similar attack but progressed from column to column gradually giving more attention to visual cues. In the slightly more mature subjects a spatial type of response of choosing successive columns from row to row, giving somewhat of a stair steps pattern, was noticed. Many sought a definite spatial arrangement of the cards sounding buzzers. This last type of attack was indicated by placing the wand in position before a row of cards was exposed, in the spontaneous remarks, and in the reasons for test choices. Subject JH (C.A. 14-5, M.A. 13-8) was so strongly set for this method of attack that although he happened to notice the configurational characteristic after 52 revolutions on the un-inscribed series he reverted to his spatial attack on the idem series, given subsequently, and failed to learn during 60 revolutions after which experimentation was discontinued. Mentally deficient subject brc and all the normal subjects requiring more than the medium number of revolutions for learning gave some indication of this type of spatial attack. When confronted with a test series HI remarked, "I don't know where I'm at." Changes in prejudices for particular columns and cards are easier to follow. It has been pointed out that both groups were prejudiced against the first and fifth columns. Subject FC distributed his choices by columns 3, 97, 90, 165, 5 for the first sitting. During the next three sittings he made no choices in columns one and five. In the fifth sitting there were nine choices in column 1 and 15 in column 5. In the sixth sitting 75 choices were made in column 1 and 63 in column 5. All of the choices that were shifted in sitting six from where they had fallen in sitting five with one exception were changed to columns 1 or 5. Subject AC was an exception to the trend of the group in his column preference. His column

choices for the first sitting were 100, 49, 55, 21, 135. With a less distorted distribution, the shift is less noticeable; but in his last sitting, AC's choices are about equally distributed as to columns. The progression of preferences for particular cards is readily seen in all the subjects' records of choices (see tables I to VI). In some rows the first preference is for the card that sounds the buzzer. These preferences for the right cards are usually retained but, occasionally, there is shifting from a right to a wrong preference. After subject ed had chosen the right card in row 12 on fourteen successive revolutions, she shifted to the fourth card in that row, choosing it on fifteen of the next sixteen revolutions. Other similar transfers (see table IV) indicate that a change in the reaction to the problem as a whole, such as favoring a column previously neglected, may result in the erroneous shifting of some of the subordinate responses. The records also show that subjects often had to learn by means of a series of preferences that each of the four wrong cards in a row did not fit into the total response of getting buzzes. Subject BP pointing to a card chosen several times in succession remarked, "That's a wrong one." It appears that the repetitions of errors are neither stupid nor useless but are necessary steps in the progression of integrating the responses into an uninterrupted series of buzzes.

A comparative study of the preference shifting in the records of the normal and mentally deficient subjects shows characteristic differences similar to those noted above. The two groups start out with similar attacks. Their position and card preferences are almost parallel (see figure 2) but the normal subjects are evidently influenced more by the relevancy of a choice to the total situation, for their preferences for wrong cards have shorter duration and they less frequently revert to former preferences. Consequently, the normal subjects, on the average, integrate their responses into a more rapid progression. The difference between mentally deficient and normal subjects appears and grows with experience as a result of their spontaneous reaction to the effectiveness of their selections.

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Discussion

President Greene:—

I think we start off very auspiciously with this paper by Dr. Whiteside this morning.

Dr. Edgar A. Doll (Vineland, N. J.):—

It is rather awkward to discuss a paper one has not read, especially when the merit of that paper depends upon the scientific proof of the validity of the conclusions. From the data presented the merit of the paper is difficult to judge.

It seems to me rather odd (if I understood the report correctly) that there should be no correlation with life age, a low correlation with mental age, and yet a fairly high correlation with I.Q. Also, even if the differences between the two groups are reliable differences, it is important also to know the amount of those differences—that is, their size as well as their reliability.

We should also bear in mind the general scheme of this paper, that in studying the learning differences between the normal and the feeble-minded, it is quite important to be sure that the learning situation itself is not capitalizing one feature or another of the assets or liabilities of the particular groups in question. The general literature on the learning differences between the normal and the feeble-minded is very confusing because of the selective nature of the learning material. One can select a learning task which will prove the normal superior to the feeble-minded, and one can select other learning tasks, which will show the feeble-minded superior to the normal.

One of the most important things we need in getting at the differences in learning between these two groups is to bring together a wide variety of different types of learning situations. When that is done, the literature so far shows a general tendency for the normals to learn better in situations which have large abstract influence and relatively low effect on memory; while the feeble-minded have a tendency to show a better learning in those situations which deal with memory and concrete situations. Since the comparison of the two groups means that the feeble-minded group usually has the higher chronological age, it is obvious that any learning situation which places a premium on experience or age, will operate in favor of the feeble-minded group.

Dr. Stella Whiteside (Detroit, Michigan):—

I should like to make clear the general picture that in this particular learning situation, chronological age, seemingly, is not a factor in the difficulty of learning by memory. While more of the immature subjects, particularly in the mentally deficient group, learned by memory, we find

just as long learning curves in the records of the older subjects learning by memory.

Above a certain maturity, about the eighth chronological year, the normal subjects are just as successful as the older normal subjects and more successful than the older mentally deficient subjects in the use of the configurational characteristic.

In spite of the lack of importance of chronological or mental age, perhaps because the situation is not difficult, the normals learning by memory have a mean of 43 revolutions while the mean for the mentally deficient subjects was 85 revolutions.

